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BARBER COLMAN

PORTABLE POTENTIOMETERS

MODELS PA10, PA11

OPERATING and SERVICE MANUAL

BARBER-COLMAN COMPANY
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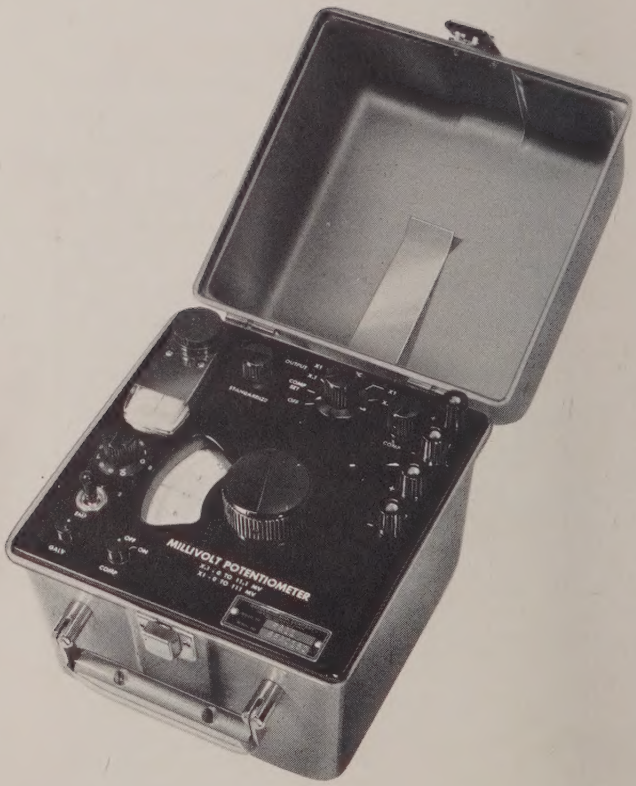

MODEL PA10
PORTABLE POTENTIOMETER

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FIGURES

FIGURE I — Panel Layout ..... Inside Front Cover
FIGURE II — Schematic Diagram ..... 6 & 7

PORTABLE POTENTIOMETERS

MODELS PA10, PA11

1. INTRODUCTION

The Barber-Colman PA Series of portable potentiometers has been designed as general purpose instruments for fast and efficient operation in the laboratory, plant and field. With the exception of a run-up box mounted in the cover of the Model PA11, the elements of both the PA10 and PA11 are identical.

A special feature of both Models for thermocouple emf measurements is the manual reference-junction compensator for the emf of the thermocouple reference-junction. The instruments may be used to check null-balance and deflection millivoltmeters, to measure thermocouple emfs, to provide a millivolt source for calibrating recorders and controllers and to measure any emf within its range. Figure I locates and identifies the top panel components.

2. SPECIFICATIONS

Range

The measuring ranges are 0 to 111 millivolts and 0 to 11.1 millivolts. On the high range, 0 to 111 millivolts, the Decade Switch (11, Figure I) is calibrated in ten, ten millivolt steps for a total range of 0 to 100 millivolts; the Slidewire has 220 divisions, each division equal to 50 microvolts for a total range of 0 to 11 millivolts.

On the low range, 0 to 11.1 millivolts, the Decade Switch is calibrated in ten, one millivolt steps for a total range of 0 to 10 millivolts; the Slidewire has 220 divisions, each division equal to 5 microvolts for a total range of 1.1 millivolts.

Limit of Error

High Range ±(0.05% of reading plus 20 microvolts)
Low Range ±(0.05% of reading plus 5 microvolts)

Current Drain

The current drain on the measuring circuit batteries is 5.5 milliamperes.

Compensator

The Compensator is a ten-turn rheostat with a range of 0 to 5 millivolts, adjustable to 5 microvolts. The Compensator is set by rotating the Function Selector Swtich (4, Figure I) to the "COMP SET" position, locking down "COMP" key (8, Figure I), then balancing the "COMP" rheostat (5, Figure I) against the setting of the Decade Switch (11, Figure I) and Slidewire (7, Figure I) while tapping the "GALV" key (9, Figure I).

Example

To compensate for a 2.5 millivolt reference-junction proceed as follows:

(a) Set 20 on the Decade Switch.

(b) Set 5 on the Slidewire.

(c) Set Function Selector Switch to "COMP SET" position.

(d) Depress and rotate "COMP" key clockwise to "ON" position.

(e) Tap "GALV" key while rotating "COMP" rheostat until Galvanometer nulls.

After completion of steps (a), (b), (c), (d) and (e), the Compensator will remain set as long as the "COMP" key is in the "ON" position regardless of the setting of the Decade Switch, Slidewire, or Function Selector Switch.

Note: On "COMP SET" position Potentiometer is automatically on low range (0 to 11 millivolts) and should be read accordingly.

Galvanometer

The built-in detector is a pointer Galvanometer with the following characteristics:

Resistance	11 ohms
CDRX	35 ohms
Period	4 seconds
Sensitivity	1 microampere/mm

3. PHYSICAL DESCRIPTION — BOTH MODELS

The Model PA10 comprises a vacuum-formed ABS polymer box and removable lid, two pairs of binding posts, a six-position Function Selector Switch, a dual battery adjusting Rheostat, a ten-turn Compensating Rheostat, a binding post Selector Switch, a 10-step Decade Switch, a pointer Galvanometer, a compensator ON-OFF Key, a Galvanometer key, and a 14½" Slidewire with associated resistors and batteries. Model PA11 is similar but with the addition of a run-up box located in the instrument cover.

4. BASIC CIRCUIT DESCRIPTION

Referring to Figure II, schematic diagram, the battery current drain is 5.5 milliamperes. When the Function Selector Switch is in the "EMF X1" or "OUTPUT X1" position the current divides in a 10:1 ratio with 5 milliamperes across the Step Switch and Slidewire producing the balancing emf, and 0.5 milliampere being shunted through the branch circuit.

When the Function Selector Switch is in the "EMF X.1" or "OUTPUT X.1" position the current divides in a 1:10 ratio with 0.5 milliampere across the Step Switch and Slidewire producing the balancing emf, and 5 milliamperes being shunted through the branch circuit.

When the Function Selector Switch is in the "SC" position an emf is produced, by adding or deleting resistance with the "STANDARDIZE" Rheostat, that is equal to the Standard Cell emf. When this case occurs the circuit is adjusted to give a zero deflection or "null" on the Galvanometer.

MODEL PA10

5. CONNECTIONS

Connect the instrument or thermocouple to be checked to the EMF binding posts observing proper polarity.

6. OPERATION

6-1 Galvanometer Zero Adjustment

Adjust the Galvanometer pointer to the zero line on the scale, if required, by rotating adjustment knob (1, Figure I).

6-2 Current Standardization

A. Rotate Function Selector Switch (4, Figure I) to "SC" position.

B. Tap the "GALV" key and adjust the "STANDARDIZE" Rheostat (3, Figure I) until balance (zero deflection) is indicated on the Galvanometer.

6-3 Taking a Reading

A. Connect the emf to be measured to either pair of "EMF" binding posts (6, Figure I) using copper wire and observing proper polarity. Set "EMF 1-2" binding post Selector Switch (10, Figure I) to correspond to binding post in use.

B. Adjust the Galvanometer zero (6-1).

C. Standardize the current in the Potentiometer (6-2).

D. Set the Function Selector Switch to "EMF X1" position.

E. Rotate the ten-step Decade Switch (11, Figure I) and Slidewire (7, Figure I) to their maximum positions. While tapping the "GALV" key (9, Figure I), rotate the Step Switch counterclockwise until the Galvanometer deflection reverses, then back up one step. Continue to tap "GALV" key and balance Slidewire. If final balance is obtained at "0" setting of the Step Switch it is obvious that a more accurate measurement can be made with the Function Selector Switch set to "EMF X 1" position.

7. APPLICATION

7-1 Checking Null-Balance Potentiometers

A. Connect the instrument to be tested to either pair of "EMF" binding posts (6, Figure I). Use copper wire and observe proper polarity.

B. Position the Binding Post Selector Switch (10, Figure I) to correspond to the "EMF" binding posts in use.

C. Adjust Galvanometer zero (6-1).

D. Adjust the current in the Potentiometer (6-2).

E. Standardize the Potentiometer to be checked, if required.

F. Set the Function Selector Switch (4, Figure I) to the "OUTPUT X1" or "X.1" position (depending on desired millivoltage).

G. Set the ten-step Decade Switch (11, Figure I) and Slidewire (7, Figure I) to the desired setting.

H. Balance the Potentiometer being tested and observe the reading.

Note: By repeating above procedure at various test settings, a series of correction factors may be obtained.

7-2 Temperature Measurement with a Thermocouple

A. Connect the thermocouple leads to either pair of "EMF" binding posts (6, Figure I) observing proper polarity.

Note: If it is not convenient to bring the thermocouple extension leads to the "EMF" binding post, copper leads may be used. If copper leads are used, the reference junction will be at the point where the copper leads are connected to the thermocouple extension leads.

B. Measure the thermocouple reference-junction temperature with an accurate mercury-in-glass thermometer. Note that the reference-junction is at the point where the thermocouple extension leads are connected to the Potentiometer.

C. Standardize the Potentiometer current (6-2).

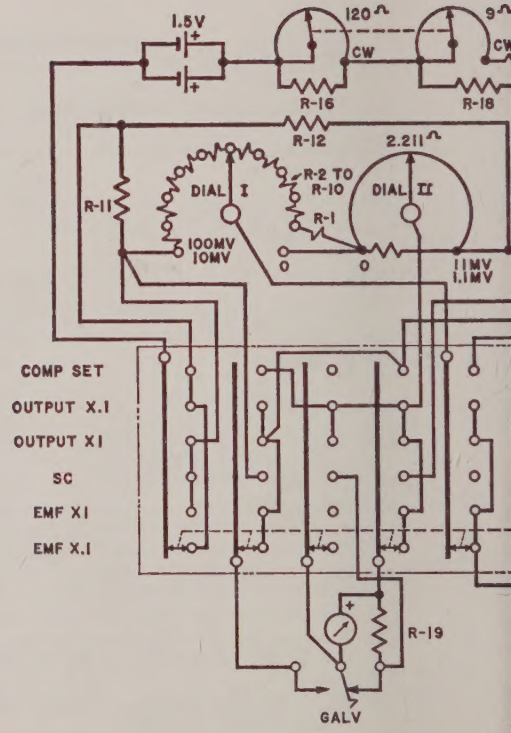
D. Position the Binding Post Selector Switch (10, Figure I) to correspond to the "EMF" binding posts in use.

E. Set Function Selector Switch (4, Figure I) to "COMP SET" position.

F. Depress "COMP" key (8, Figure I) and turn clockwise to lockdown in the "ON" position.

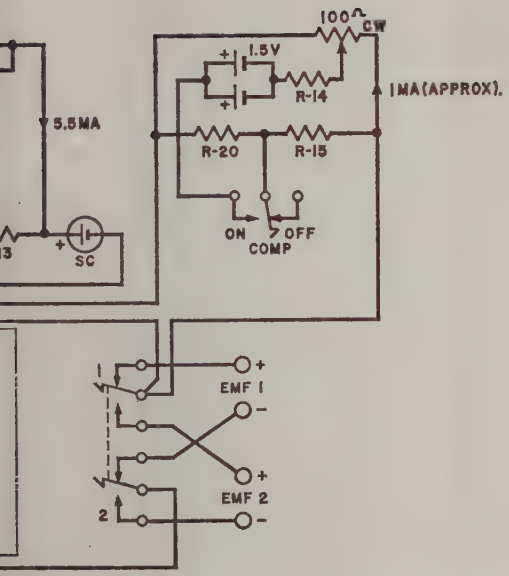
G. Set ten-step Decade Switch (11, Figure I) and Slidewire (7, Figure I) to the emf value corresponding to the thermocouple reference-junction temperature of step (B).

Note: Refer to Section 2 paragraph on Compensator.



FI

REF. DESIGNATION	NO. REQ'D.	VALUE IN OHMS
R1	1	2
R2-R10	9	2
R11	1	199.9
R12	1	22.211
R13	1	165.135
R14	1	1300



E II

REF. DESIGNATION	NO. REQ'D.	VALUE IN OHMS
R15	1	5
R16	1	470
R17	1	15
R18	1	56
R19	1	39

H. Depress "GALV" key (9, Figure I) and adjust "COMP" rheostat until balance (zero deflection) is indicated on the galvanometer.

I. Rotate Function Selector Switch to "EMF X1" or "X.1" position.

J. Depress "GALV" key and adjust the Potentiometer Decade Switch and Slidewire until balance is indicated on the Galvanometer.

K. Read the setting of the Potentiometer and obtain the corresponding thermocouple temperature from the appropriate table.

Note: In measuring temperature with thermocouples it should be understood that the thermocouple forms a closed circuit from the measuring junction through the "EMF" binding posts, Galvanometer and Potentiometer measuring circuit. An emf of opposite polarity to that of the measuring junction is developed at the reference junction ("EMF" binding post) so that the Potentiometer measures the algebraic sum. Manual reference-junction is provided to compensate for this reference-junction emf so that a series of millivolt readings may be taken and corresponding temperatures read directly from the tables without making further corrections.

7-3 Checking Thermocouples

In order to check a thermocouple, some means of maintaining the measuring-junction of the thermocouple at a known temperature is required.

The procedure for the calibration of the thermocouple at the known temperature is the same as that described in Section 7-2.

7-4 Comparing Two Thermocouples

The Model PA10, Compact Portable Potentiometer, being equipped with two sets of "EMF" binding posts, is especially well adapted for checking one thermocouple against another.

A. Place the two thermocouple measuring ends close together in a temperature controlled environment.

B. Connect the reference-junctions to the "EMF 1" and "EMF 2" binding post.

C. Set binding post Selector Switch to the number corresponding to the binding posts to which the "Standard" thermocouple is connected, and take a reading. Record reading in millivolts.

D. Repeat Section 7-2 steps B-C-D-E-F-G-H-I.

E. Set binding post Selector Switch to the opposite setting of step (D) and read the second thermocouple. This shows immediately the deviation of one thermocouple from the other in millivolts. If the difference in degrees is desired reference to the appropriate table is necessary.

7-5 Checking Null-Balance Thermocouple Pyrometers

A. Connect the instrument to be tested to the "EMF" binding posts.

B. Position binding post Selector Switch (10, Figure I) to correspond to the "EMF" binding posts in use.

C. Determine the reference-junction temperature at the terminals of the instrument being tested and set up the proper reference-junction compensation emf as described in Section 7-2 (B) to (K).

D. Rotate the Function Selector Switch to the "OUTPUT" position.

E. Set the millivolt value corresponding to the pyrometer reading to be checked on the Potentiometer Decade Switch and Slidewire.

F. Balance the pyrometer being tested and observe the reading.

8. MAINTENANCE

8-1 General

With normal use the only maintenance required will be replacement of the potentiometer batteries and an occasional cleaning and lubrication of the slidewire after

long periods of disuse. Potentiometers having only periodic use should have their measuring dials rotated several times over their full travel previous to making a measurement. All maintenance requires removal of the potentiometer from its case.

8-2 Case Removal

A. To remove case turn potentiometer on its side, support panel and with coin or screw driver, turn case fastener on bottom of case one quarter turn counterclockwise to disengage. The panel will now slide out. The panel may be inverted in the case which serves as a convenient holding fixture while any necessary maintenance is being performed.

B. To replace panel, grasp slidewire knob, orient the two hinge clearance notches with the hinges and slide into case. Engage fastener and rotate clockwise ¼ turn to lock. A firm pressure applied on the panel and the slotted fastener will facilitate engagement.

8-3 Batteries

A. Replacement of battery in the measuring circuit will be required when full clockwise rotation of the battery rheostat does not permit standardization of the potentiometer, i.e. inability to null galvanometer when in SC position and while depressing galvanometer key or; when frequent restandardizing is required indicating near exhaustion of the batteries.

B. Replacement of battery in the compensator circuit will be required when it is no longer possible to null galvanometer when setting the "Comp" rheostat against the decade switch and slidewire.

C. Each of the above circuits uses two 1½ volt size "D" flashlight cells in parallel.

D. Remove case (8-2-A).

E. Remove batteries as required and replace as required, observing proper polarity as indicated on the battery holders.

F. Replace case (8-2-B).

8-4 Slidewire

A. The need for slidewire cleaning is indicated by erratic deflection of the galvanometer when smooth slidewire rotation is applied while at or near balance when standardizing or measuring with galvanometer key depressed.

B. Remove case (8-2-A).

C. Clean slidewire surface by rubbing briskly with a soft cloth moistened with naphtha or other volatile petroleum solvent in a direction parallel to the wire convolutions. DO NOT USE ALCOHOL or CARBON TETRACHLORIDE. Dry with soft cloth. Lubricate by rubbing with a soft cloth sparingly impregnated with white petroleum or petroleum jelly.

D. On severely oxidized slidewires not cleanable by "C" above, polish gently with crocus cloth uniformly over full length of slidewire parallel to convolutions and repeat (8-4-C).

E. Replace case (8-2-B).

8-5 Push Keys

A. Failure of the push keys to make will be indicated by the galvanometer swinging freely (undamped) when attempting to standardize or make a measurement, or the failure to deflect when an unbalance is known to exist.

B. Key contacts may be cleaned by inserting a thin strip of bond paper or business card between the contacts and applying pressure to the contacts by depressing or releasing the key button as required while withdrawing the paper. Repeat three or four times, or as necessary.

8-6 Galvanometer

A. Galvanometer failure usually occurs by suspension breakage due to a severe shock. It is indicated by failure of the pointer to swing freely under open circuit conditions. To detect, remove any wires from

EMF binding posts, position the Function Switch at EMF X1 or EMF X.1. Depress the GALV key and impart a slight rotational motion. If the suspension is broken the pointer will not swing.

B. To dismount the galvanometer, remove the two screws adjacent to the Zero Adjustor and lift straight up. Return to factory for repairs. CAUTION: USE MINIMUM OF 2 INCHES OF CUSHIONING ON ALL SIDES OF GALVANOMETER.

8-7 Standard Cell

A. The standard cell is an "H" shaped glass enclosure which maintains a constant voltage of approximately 1.0193 volts at 20°C and is used as the standardizing or calibrating voltage for this instrument. The occasional exposure of the standard cell to temperature less than 40°F or above 140°F will not necessarily damage the cell, but should be avoided. Use of the instrument in such ambient temperature will probably result in inaccurate readings caused by the EMF change in the standard cell.

B. To replace the standard cell proceed as follows:

1. Remove the potentiometer from its case as described in section 8-2-A.
2. Note and tag the position of the standard cell red and black leads.
3. Unsolder the red (+) lead and the black (−) lead from their points of termination.
4. Remove the batteries from the standard cell side of the battery bracket. Loosen the straps and remove the standard cell.
5. Insert the new standard cell and follow the reverse of the above procedure.

8-8 Measuring Circuit

A. Calibration and repair of the measuring circuit should only be attempted in the laboratory under

controlled conditions. For maintenance operations not described above, it is recommended that the instrument be returned to the factory.

MODEL PA11

In general, the information concerning the use of the Model PA10 also applies to the Model PA11. However, Model PA11 includes a run-up box mounted in the cover of the instrument case. This run-up box is electrically connected from one set of emf terminals on the instrument face to the potentiometer terminals of the unit. Its METER terminals are connected to the input terminals of the instrument to be tested. The potentiometer is set at the millivolt value to be checked.

The Run-Up box RANGE switch is then turned to the required test range and the LEAD RESISTANCE rheostat is adjusted to the known value of external resistance normally existing when the instrument is in use. If the instrument is a null-balance type, the rheostat is set in the off (zero) position.

The Run-Up knobs are then adjusted until the potentiometer-galvanometer indicates a balance. The potentiometer setting then equals the millivoltage applied to the instrument; for deflection-type instruments, the current flow is correct. The reading of the instrument, in terms of millivolts, is then compared with the potentiometer reading.